

Self-administration of a questionnaire on chest pain and intermittent claudication

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SUMMARY A total of 18 403 men aged between 40 and 64 years took part in a screening examination which included a self-administered version of the London School of Hygiene questionnaire on chest pain and intermittent claudication. The yield of positives for 'angina' and 'history of possible infarction' was about twice as high as with interviewers, but the positive groups obtained by the two techniques differed little in their association with electrocardiographic findings or in their ability to predict five-year coronary mortality risk. This risk ranged from 0.9% in men negative to questionnaire and electrocardiograms (ECG), to 4.3% for those with positive ECG but no symptoms, 4.5% for those with angina and negative ECG, up to 16% for those with angina and positive ECG. The self-administered version of this questionnaire provides a simple and convenient means of identifying individuals with a high risk of major coronary heart disease.

In population surveys of coronary heart disease (CHD) an assessment of symptoms provides a potentially important measurement of disease at a low extra cost. A standard questionnaire on chest pain and intermittent claudication (Rose, 1962) has been widely used and evaluated. Originally it was designed for use by doctors and nurses, but subsequently a self-administered version was developed. This has the advantages that it avoids the problem of observer variation; it can be completed in advance by subjects, thereby saving time at the examination; it can be used in postal surveys or other situations where personal contact with participants is not practicable; and it is cheaper. Some results of its use are now reported.

Procedure

A few small changes in the wording of the original questionnaire were necessary to make it suitable for self-administration. Since exact standardisation is essential, the new version is reproduced in the Appendix. Its purpose is to identify individuals with angina of effort, a history of possible myocardial infarction, or intermittent claudication. The criteria for identifying these three categories remain unchanged in the self-administered version.

A total of 18 403 male civil servants aged between 40 and 64 years took part in a cardiorespiratory screening survey in Inner London, the Whitehall

Study. Details have been published elsewhere (Reid *et al.*, 1974). A few days before his examination each man received a copy of the questionnaire, which he was asked to complete and bring with him to the survey centre. At that time a nurse checked his answers for completeness, although this did not often prove to be at fault. Later she classified his reported symptoms according to the agreed rules.

COMPARISON WITH ADMINISTRATION BY INTERVIEWER

In one of the government departments studied the men eligible for participation were divided by alternate allocation into two groups. In one group the usual routine was followed for pre-circulation and self-administration of the questionnaire, which permitted men to ponder their symptoms at leisure and, if they chose, to discuss the matter with their wives. In the other group the questionnaire was printed without the sections relating to chest pain or intermittent claudication. When the men attended for examination the missing questions were put to them by a nurse who had been trained in the usual standardised techniques for this questionnaire; this procedure allowed the subject only a few seconds for recollection. In the subsequent coding and analysis the questionnaires from the two groups were handled identically.

The results of the comparison are summarised in Table 1. The unequal size of the groups was due to

Table 1 *Comparison of the results of interviewer and self-administration of the chest pain questionnaire, randomised group*

Examined	Total		ECG-positive*	
	Interviewed	Self-administered	Interviewed	Self-administered
Total	938 (100.0)	998 (100.0)	69 (7.4)	81 (8.1)
Positive to 'angina'	28 (3.0)	76 (7.6)	5 (18.0)	14 (18.0)
'possible infarction'	36 (3.8)	67 (6.7)	7 (19.0)	10 (15.0)
either	58 (6.2)	126 (12.6)	11 (19.0)	18 (14.0)

*Minnesota Code 1.1-3 or 4.1-4 or 5.1-3 or 7.1.

Percentages are given in parentheses.

a chance difference in response rate, which was 72% in the self-administration and 68% in the interviewed group. The overall prevalence of positive ECG findings was 7.4% in the self-administration group and 8.1% in the interviewer-administration group: thus it seems that the two groups were initially comparable in the prevalence of ischaemic disease as ascertained by ECG. There were also no significant differences in their mean levels of blood pressure, plasma cholesterol, cigarette consumption, or age. However, for both 'angina' and 'possible infarction' the prevalence of positive results was about twice as high in the self-administration group. This excess was consistent within each of the five grades of employment. For intermittent claudication the numbers were small, but no difference was apparent: 0.7% were positive in each of the two groups.

The men who were able to complete their questionnaires in a more leisurely fashion at home might be more likely to record minor or irrelevant symptoms. To the extent that this was true, then the increased number of positive classifications from self-administration would include higher proportions both of false positive cases and of true but milder positive cases. The results of electrocardiography were available as a measure of these tendencies (Table 1). It appears, surprisingly, that the proportion of men who reported positive symptoms either of 'angina' or of 'possible infarction' and who had a positive ECG was much the same (14% to 19%), regardless of the technique of administration of the questionnaire. In other words, self-administration has not produced any major loss of specificity or dilution with less severe cases. Numbers, however, are small, and the range of possible sampling error is correspondingly wide.

During the period from screening to the present time 129 of the 1936 men have died, these deaths being almost equally divided between the two groups (Table 2). However, the proportion attributed to myocardial infarction was different, comprising

36 (54%) of the 67 deaths in the interviewed group compared with 20 (32%) of the 62 deaths in the self-administration group. This chance difference might lead to relative underestimation of the risk associated with a positive questionnaire in the self-administration group; but it was nevertheless found that in this group a positive questionnaire response (to angina and/or possible infarction) carried a mortality ratio for myocardial infarction of 4.6, and this was only a little lower than that observed in the interviewed group (mortality ratio 5.8). Although the numbers involved are small it again appears, as in the electrocardiographic analysis, that self-administration has not led to any major loss of specificity, measured by predictive power.

RELATIONSHIP OF SYMPTOMS WITH ECG FINDINGS

In the main study each ECG was coded in duplicate by Minnesota Code criteria (Rose and Blackburn, 1968), and in cases of disagreement the final code was determined by one of the authors. For the current analysis an ECG was classified as positive if it showed any evidence of suspect ischaemia (that is, Q/QS items, codes 1.1-3; S-T/T items, codes 4.1-4 or 5.1-3; or left bundle branch block, code 7.1). Chest leads were not recorded, and it is estimated that this reduced the number of cases with evidence of suspected ischaemia by about 25%. The relationship between various symptom categories and the ECG findings is shown in Table 3.

For each symptom category the prevalence rates rise steeply with age, the gradient being steepest for grade 2 angina (that is, the more severe of the two grades, and probably the most specific of the questionnaire symptom groups). The proportion of men with angina who also had ECG findings suggesting ischaemia ranged from 9% for men aged between 40 and 49 years with grade 1 up to 34% for men aged between 60 and 64 years with grade 2. This proportion also rose steeply with age; but the slope was similar to that for the prevalence of ECG findings in the study group as a whole, so

Table 2 *Comparison of mortality from myocardial infarction and all causes in the interviewed and self-administration groups, randomised group*

Group	Interviewed (No. = 938)		Self-administered (No. = 998)	
	Myocardial infarction	All causes	Myocardial infarction	All causes
Total	36 (3.8)	67 (7.1)	20 (2.0)	62 (6.2)
Angina and/or possible infarction	10 (17.0)	12 (21.0)	8 (6.0)	17 (13.0)
Positive ECG	5 (7.0)	10 (14.0)	7 (9.0)	14 (17.0)

Percentages are given in parentheses

Table 3 *Prevalence of various symptom categories and their relationship to ECG findings, by age, Whitehall group*

Symptom category		40-49 years	50-59 years	60-64 years	All ages adjusted
Study group	total	7732	8284	2387	18 403
	ECG+	278 (3.6)	609 (7.4)	264 (11.1)	1151 (6.3)
Angina grade 1	total	204 (2.6)	365 (4.4)	155 (6.5)	719 (3.9)
	also ECG+	18 (9.0)	59 (16.0)	31 (20.0)	108 (14.0)
grade 2	total	27 (0.4)	93 (1.1)	44 (1.9)	164 (0.9)
	also ECG+	3 (11.0)	21 (23.0)	15 (34.0)	39 (19.0)
Possible infarction	total	422 (5.5)	612 (7.4)	197 (8.3)	1231 (6.7)
	also ECG+	16 (4.0)	104 (17.0)	43 (22.0)	163 (12.0)
Intermittent claudication	total	47 (0.6)	68 (0.8)	32 (1.4)	147 (0.8)
	also ECG+	0 (0.0)	4 (6.0)	5 (16.0)	9 (5.0)

ECG+ is defined in Table 1

Percentages are given in parentheses.

that at each age a positive ECG was about twice as common in men with grade 1 angina as in the whole study group, and about three times as common for men with grade 2 angina.

Age-specific prevalence rates for possible infarction were a little higher than for angina; but the proportions of men who also had positive ECG findings were similar, except in the youngest age group. Here a positive ECG was no more frequent than in the study population as a whole, suggesting that the questionnaire positives were largely false. The extent of overlap between angina, possible infarction, and positive ECG is shown by a Venn diagram in the Figure. Although the overlap is considerably more than would occur by chance, in 86% of all these cases of suspect ischaemia there is no more than one positive finding: in other words, yield is much increased if more than one form of assessment is considered. (The mortality results in the Figure will be considered later.)

After excluding the more specific categories of angina and possible infarction there remained a large number of men, 27% of all those examined, who did not meet these specific criteria but had nevertheless answered 'Yes' to the question 'Have you ever had any pain or discomfort in your chest?' Among these men with atypical symptoms the frequency of positive ECG findings (6.6%) did not differ significantly or importantly from that in the study group as a whole (6.3%), suggesting that few of them actually had ischaemic pain: thus to

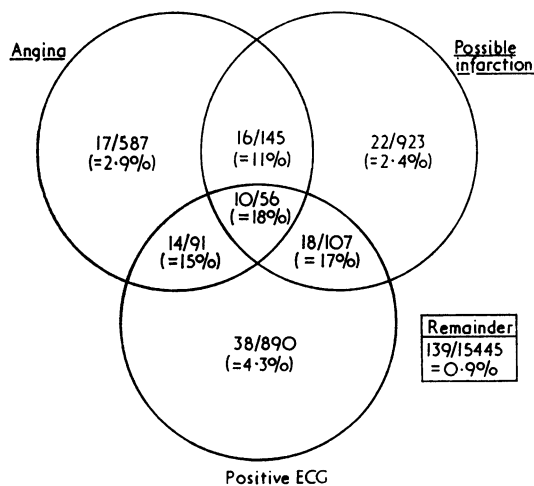


Figure Venn diagram illustrating the overlap between the symptomatic and ECG categories, and the five-year CHD deaths and mortality rates occurring in each subgroup. (Positive ECG defined as in Table 1.)

widen the criteria for angina might reduce the specificity but could not greatly improve the sensitivity.

Prevalence rates for intermittent claudication are low in this group of largely sedentary workers, and there is no suggestion of any association with positive ECG findings.

GRADE OF EMPLOYMENT AND ANGINA

Comprehension of a self-administered questionnaire and response to it might depend on educational level and cultural background, and positive verdicts would then reflect these factors as well as the presence of disease. To test this possibility further the results have been analysed according to grade of employment (Table 4). (This analysis excludes results from the Diplomatic Service, in which employment grades are categorised differently, and from men aged 60 and over, because of selective retirement.) Some important occupational differences are seen in the prevalence of angina, especially among the older men, where the rate is nearly twice as high in the lowest as compared with the highest grades of employment. However, the gradient is similar for ECG abnormalities. This suggests that the prevalence gradient is real and not just the effect of educational or cultural bias.

The last column of Table 4 shows the association within each grade between angina and ECG abnormality. Overall the prevalence of ischaemic ECG findings is between two and three times greater in those with angina than in the study population as a whole. The weakest association is seen in those

employment grades (the highest) where the prevalence of disease is lower, suggesting that disease is less severe in those groups where it is less common. This is further evidence that the prevalence gradient is not only the result of educational bias in the ascertainment of symptoms.

RELATIONSHIP OF SYMPTOMS TO MORTALITY

In more than 99% of the examined men it was possible to identify and tag the subject's record in the Central Registry of the National Health Service and in this way to obtain copies of death certificates for subsequent fatalities. Mortality follow-up is now complete for all men for a period of five years from their examinations, and the results are summarised in Table 5 and the Figure. Overall the presence of either angina or possible infarction is associated with a more than threefold increase in CHD mortality, which is just below the level of risk in men with a positive ECG. Risk is much higher where symptoms and positive ECG occur together, such findings carrying a five-year CHD mortality of over 15%; but the prevalence is lower, so that in each case less than half as many of the CHD deaths are predicted. Mortality is also high (13%) in the men

Table 4 Differences between grades of employment in the prevalence of angina and its association with positive ECG findings, Whitehall group

Age (years)	Grade	No.	Prevalence %		% of angina with positive ECG
			Angina	Positive ECG	
40-49	Administrative	470	2.6	2.8	0
	Professional/executive	5753	3.0	3.5	9
	Clerical	800	3.5	3.4	14
	Other	280	2.9	5.7	13
	All	7303	3.0	3.6	9
50-59	Administrative	419	3.1	6.0	15
	Professional/executive	5330	5.6	6.9	17
	Clerical	1348	5.8	8.5	18
	Other	805	6.0	9.4	21
	All	7902	5.6	7.4	18

ECG+ is defined as in Table 1.

Table 5 Five-year CHD mortality according to presence of chest pain syndromes or intermittent claudication in 18 244 men with complete data

	Five-year CHD deaths, no. examined (rate %)				All-ages mortality ratio (age-adjusted)
	40-49 years	50-59 years	60-64 years	Total	
Angina total	5/228 (2.2)	35/453 (7.7)	17/198 (8.6)	57/879 (6.5)	4.4
also ECG+	2/21 (9.5)	13/80 (16.2)	9/46 (19.6)	24/147 (16.3)	10.0
Possible infarction total	2/422 (0.5)	50/612 (8.2)	14/197 (7.1)	66/1231 (5.4)	3.9
also ECG+	0/16 (0.0)	22/104 (21.2)	6/43 (14.0)	28/163 (17.2)	8.3
Other chest pain or discomfort	9/1798 (0.5)	28/1738 (1.6)	20/461 (4.3)	57/3997 (1.4)	1.0
Intermittent claudication	1/47 (2.1)	5/68 (7.4)	1/32 (3.1)	7/147 (4.8)	3.1
Study group total	34/7671 (0.4)	164/8216 (2.0)	76/2357 (3.2)	274/18244 (1.5)	—
ECG+	9/277 (3.2)	47/604 (7.8)	24/264 (9.1)	80/1144 (7.0)	5.3

ECG+ is defined as in Table 1.

Percentages are given in parentheses

who are positive to both of the two symptom categories.

Age-specific analysis shows that among men under the age of 50 the syndrome of 'possible infarction' carries no measurable increase in risk—the same conclusion as was indicated by the electrocardiographic analysis. For angina, the mortality ratio is not significantly different between the age groups. However, in the younger age group the absolute risk is low, although the estimate is based on small numbers.

Where symptoms occur in men with negative ECG findings the prognosis is better, although still significantly higher than in men without symptoms: for angina with negative ECG the mortality ratio is 3.3, and for possible infarction with negative ECG it is 2.6. After identifying the defined syndromes of angina and possible infarction there remains a large group of men with 'other chest pain or discomfort' who have answered positively to the first question in the questionnaire; this finding seems to carry little or no increase in the risk of CHD death.

The number of men with intermittent claudication was too low to yield a reliable estimate of prognosis. Their CHD mortality appeared to be increased to a similar extent as that for angina.

Discussion

The self-administration version of the London School of Hygiene questionnaire offers a simple and cheap means of ascertaining certain manifestations of atherosclerotic disease. It has been widely used in population studies, and it also has a place in clinical trials. Admittedly the civil servants studied in this report are men to whom form-filling is an unusually familiar exercise; but the result was encouraging when the same questionnaire was sent by post to random national samples (Reid *et al.*, 1966; Zeiner-Henriksen, 1976), with response rates around 80%, relatively few missing or manifestly wrong answers, and estimates of mortality prediction broadly similar to those in the present study and in the previously reported follow-up of the interviewer-administered version (Rose, 1971).

The successful use of questionnaires is known to require standardisation of wording and interviewing technique. The experience reported here reveals that the mode of administration is also crucially important. Self-administration, which has the advantage of eliminating observer variation, seemingly doubles the estimates for angina and possible infarction (Table 1). A similar difference was found in a Norwegian study in which men who first answered this questionnaire by post were later

re-assessed by personal interview (Zeiner-Henriksen, 1972). The use of almost the same words in each form of administration should not disguise the fact that these are two distinct techniques the results of which cannot be directly compared.

It would be expected that the much higher yield of positive results with self-administration would be achieved at the price of serious dilution with false-positive or milder cases, and it was surprising to find no support for this view when the ECG was used to compare the validity of the two groups. Furthermore the follow-up results for the study as a whole show a predictive power for CHD mortality that is high (mortality ratios around 4) and of a similar order to that in previous studies based on interviewer administration. It had been hoped to make some direct comparison within the current study on the predictive power of the two categories of questionnaire positives (based on interviewer and self-administration). Unfortunately the small numbers of deaths in this part of the study, and a chance difference in the distribution of their causes, prevented any reliable conclusions.

The experience reported here confirms the ability of the simple technique to identify a group of middle-aged men who are at relatively high risk of developing major complications of CHD during the next few years. Among men aged 50 and over, the five-year mortality rates were similar in each of the three categories of positive screening findings: angina, possible infarction, and resting ECG positive for Q/QS, S-T, or T items. It should however be emphasised that despite the high relative risk in these men, in each group more than 90% of them were still alive five years later; and from the results of previous studies it seems that most survivors are not seriously incapacitated. Those who are familiar with the much more serious import of angina clinically, should be aware that this is the outcome of the selective processes culminating in hospital referral. In the less selective situation of a screening examination this disease tends to be remarkably common but much milder than in hospital.

The questionnaire identifies a group with a high risk of CHD death. In this connection it was found that 11% of men were classified at screening as having either angina or possible infarction, and this group contributed 35% of the five-year deaths from CHD. In comparison, the ECG was positive in 7% of men, this group contributing 29% of the deaths. The presence in the same individuals of both angina and ECG changes identifies a smaller group (0.8% of the total examined) with a much higher risk, their five-year CHD mortality being 16%; but because of its low prevalence this group

contributes less than half as many CHD deaths as the group with angina alone. Similar results apply to the group with both a history of possible infarction and a positive ECG.

The validity of these symptomatic diagnoses in absolute terms (that is, the actual numbers of false positive and negative diagnoses) cannot be known, since no perfect reference test exists. Invasive techniques such as coronary angiography are inappropriate, and could in any case neither prove a false negative nor even wholly disprove a positive diagnosis. The best that can be done is to assess validity indirectly in relation to other measures of disease which are themselves imperfect or incomplete. The comparisons made here are with electrocardiography and with subsequent mortality. The proportion of men classified as having angina who also had a positive resting ECG (limb leads only) ranged from 9% to 34% in the various subgroups of age and severity (Table 3), these rates being two to three times higher than in the study group as a whole. The relationship between a history of possible infarction and electrocardiographic findings was similar among the men over the age of 50, but among younger men it seems that a history of severe chest pain is usually a non-specific finding.

This pattern is broadly repeated by the mortality findings, but the CHD mortality ratios for questionnaire-positive men are somewhat higher than the corresponding ECG prevalence ratios. Again, below the age of 50 years severe chest pain shows little association with either electrocardiographic findings or subsequent mortality. With this exception, when the questionnaire and ECG are compared in their ability to predict CHD death, there appears to be little difference. This is true whether prediction is measured by relative risk, absolute risk, or the proportion of deaths predicted; but, due to a surprisingly small degree of overlap, a combination of the two techniques is a great deal more effective than either alone. In fact, taken together these two simple methods of examination gave advance warning of half of all the deaths from CHD in these men during the ensuing five years.

In contrast with earlier studies (Rose, 1965) there was on this occasion no evident association of ECG findings with an assignment of intermittent claudication; but estimates of the association of claudication with mortality, although based on small numbers, were of the same order as for angina.

The ability of the questionnaire to identify a disease-rich group within one population has been clearly shown. Because it is cheap and simple it seems to offer possibilities for contrasting the amount of disease in different populations (Reid

et al., 1966; Marmot *et al.*, 1973); but the large effect on prevalence estimates of using self rather than interviewer administration, as reported here, is a warning that cultural differences too might bias the outcome. In the present study the prevalence estimates for angina differed widely in the various occupational grades of the Civil Service (Table 4); but on the other hand similar differences are manifest even for the more objective electrocardiographic findings. In fact, among men assessed by the questionnaire as having angina, the proportion who also have ECG changes is greatest among the lower occupational grades, where angina is most prevalent. Within this relatively narrow cultural span there is then no positive evidence that the questionnaire results have been influenced by cultural or educational differences. Nevertheless it is recommended that this technique should be used only to compare groups from different cultures or countries where its findings can be shown to be consistent with other independent measures of disease, such as mortality or the electrocardiogram.

We are grateful to the Civil Service Department, its Medical Adviser (the late Sir Daniel Thomson) and his colleagues, and the staff of the departments concerned in making this survey of civil servants possible, and to Miss L. Colwell for statistical assistance.

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Appendix

LONDON SCHOOL OF HYGIENE CHEST PAIN QUESTIONNAIRE

(Version for self-administration)

PART A

(a) Have you ever had any pain or discomfort in your chest?

1. ☐ Yes 2. ☐ No (Go to C)

(b) Do you get this pain or discomfort when you walk uphill or hurry?

1. ☐ Yes 2. ☐ No (Go to B)

(c) Do you get it when you walk at an ordinary pace on the level?

1. ☐ Yes 2. ☐ No

(d) When you get any pain or discomfort in your chest what do you do?

1. ☐ Stop
2. ☐ Slow down
3. ☐ Continue at the same pace

(e) Does it go away when you stand still?

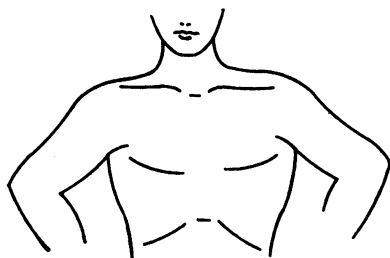
1. ☐ Yes 2. ☐ No

(f) How soon?

1. ☐ 10 minutes or less
2. ☐ More than 10 minutes

(g) Where do you get this pain or discomfort?

Mark the place(s)
with X on the
diagram.



PART B

Have you ever had a severe pain across the front of your chest lasting for half an hour or more?

1. ☐ Yes 2. ☐ No

PART C

(a) Do you get a pain in either leg on walking?

1. ☐ Yes 2. ☐ No (Go to next question)

(b) Does this pain ever begin when you are standing still or sitting?

1. ☐ Yes 2. ☐ No

(c) Do you get this pain in your calf (or calves)?

1. ☐ Yes 2. ☐ No

(d) Do you get it when you walk uphill or hurry?

1. ☐ Yes 2. ☐ No

(e) Do you get it when you walk at an ordinary pace on the level?

1. ☐ Yes 2. ☐ No

(f) Does the pain ever disappear while you are still walking?

1. ☐ Yes 2. ☐ No

(g) What do you do if you get it when you are walking?

1. ☐ Stop
2. ☐ Slow down
3. ☐ Continue at same pace

(h) What happens to it if you stand still?

1. ☐ Usually continues more than 10 minutes
2. ☐ Usually disappears in 10 minutes or less

DEFINITIONS OF POSITIVE CLASSIFICATIONS

A. *Angina* 'Yes' to a and b, 'stop' or 'slow down' to d, 'yes' to e, '10 minutes or less' to f. Site must include either sternum (any level) or L. anterior chest and left arm. GRADE 1='no' to c, GRADE 2='yes' to c.

B. *Possible infarction* 'Yes' in this section.

C. *Intermittent claudication* 'Yes' to a, 'no' to b, 'yes' to c and d, 'no' to f, 'stop' or 'slow down' to g, and 'usually disappears in 10 minutes or less' to h. GRADE 1='no' to e, GRADE 2='yes' to e.